

APPLICANT'S INITIAL SYSTEM IMPACT STUDY

GWF POWER SYSTEMS TRACY PEAKING PROJECT 115-KV INTERCONNECTION

**PREPARED BY
NAVIGANT CONSULTING, INC**

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1. INTRODUCTION AND STUDY SCOPE

GWF Power Systems (GWF) has requested that Pacific Gas & Electric Company (PG&E) conduct a System Impact/Facilities Study (SI/FS) for the proposed Tracy Peaking Project (TPP). The proposed TPP will be located at a site approximately 4 miles east of PG&E's Tesla Substation and, depending on the ultimate size of the Project, will be interconnected with: (1) the Tesla-Kasson 115-kV line; or (2) the Tesla-Kasson and Tesla-Manteca 115-kV lines. Both of these 115-kV lines are directly adjacent to the TPP property.

In its initial phase (which will be in service by July 2002) the TPP will consist of two 86 MW peaking units and will have a net output to the PG&E transmission grid of approximately 162 MW at 0.85 (lagging) power factor. Subsequently, the Project will be converted to combined cycle operation in October 2003 by the addition of an 86 MW steam turbine.

Because PG&E's proposed schedule in its SI/FS Study Plan would not provide GWF with the necessary information on transmission system impacts for use in the preparation of the Project's Application for Certification (AFC) to the California Energy Commission (CEC), GWF retained Navigant Consulting, Inc. (Navigant Consulting) to undertake studies that would identify:

- a) The impacts on the interconnected transmission system in the Study Area caused by the addition of the Project. The transmission system in the Study Area is owned by PG&E, the Western Area Power Administration, and the Modesto and Turlock Irrigation Districts, and
- b) The system reinforcements necessary to mitigate any adverse impacts of the Project.

The results of these studies are contained within this *Applicant's Initial System Impact Study Report*

2. STUDY SUMMARY

2.1 Interconnection Facilities

Depending on the ultimate size of the TPP, it will be interconnected with: (1) the Tesla-Kasson 115-kV line; or (2) the Tesla-Kasson and Tesla-Manteca 115-kV lines. Both of these 115-kV lines are directly adjacent to the TPP property.

2.2 Powerflow Studies

2003 and 2004 summer peak cases were utilized in these studies. The 2004 case was obtained from PG&E and had been utilized in previous analysis. The 2003 case was developed from the 2004 case and models:

- i. 2003 summer peak loads in the pertinent areas,
- ii. The new generators in the queue ahead of the TPP, and
- iii. The approved PG&E transmission reliability projects and projects being developed by others that will be operational by summer 2003.

These studies indicate that the addition of the TPP:

- a) Does not result in any new overloads on the PG&E system or increase any pre-TPP overloads under N-0 conditions (those in which no lines or transformers have been forced out of service).
- b) Does not result in any new overloads due to Category B outages and mitigates two such overloads noted for the pre-Project case. The addition of the Project does result in slight increases (2-5%) in some overloads. Methods of mitigating these incremental overloads would be dependent on the method(s) selected by PG&E to mitigate the pre-Project overloads.
- c) Reduces the potential for and the magnitude of overloads on the Tracy JC-Ellis line that result from Category C (N-2 outages) on various segments of the Tesla-Kasson and Tesla-Manteca lines.

If necessary, the TPP could be included in a remedial action scheme (RAS) which would trip some or all of the TPP units in the event of the outages discussed above.

Section 7 of this report contains additional information on the results of the power flow studies. Lists of the contingencies simulated are contained in Appendix A, while Appendix B contains comparative information on the results of the powerflow studies. Appendix C contains powerflow diagrams for these powerflow studies.

2.3. *Transient Stability Studies*

The transient stability studies undertaken simulated the impacts of thirty-three disturbances. Section 8 of this report describes the disturbance scenarios assessed as well as the results of the studies. Information on the

dynamics data for the TPP generators is contained in Appendix D, while dynamic stability plots for critical contingencies are contained in Appendix E.

As discussed in greater detail in Section 8 these transient stability studies indicate that the addition of the TPP has no adverse impacts on the system.

2.4. Short Circuit Studies

As discussed in Section 9, short circuit studies performed by PG&E to assess the impacts of the TPP on fault duties at Tesla indicate that the TPP should not be responsible for replacing any breakers at Tesla.

3. PROJECT INFORMATION

The proposed GWF Power Systems (GWF) Tracy Peaking Project (TPP) will be located at a site approximately 4 miles east of PG&E's Tesla Substation. The TPP will have a maximum rated generator output of 258.4 MW at 0.85 lagging power factor with a plant load of 6.7 MW. The expected maximum net output to the PG&E system is 251.7 MW. The proposed generation will consist of:

- Two gas-fired combustion turbine/generators (CTG), rated at 85.9 MW (nominal) each, which will be online by July 2002.
- One steam turbine/generator (STG), rated at 86.6 MW (nominal), which will be online by October 2003.

Each generator unit will have a dedicated 13.8/230 kV step-up transformer connected to a new 115-kV bus located the proposed Project site. The initial phase of the TPP will be interconnected with PG&E's Tesla-Kasson 115-kV line. When the second phase of the TPP is developed the Tesla-Manteca 115-kV line will be interconnected with the TPP switchyard. Both of these 115-kV lines are directly adjacent to the TPP property. The power produced by the TPP will be transmitted over PG&E's transmission system in the area.

4. INTERCONNECTION ASSUMPTIONS

With the input and concurrence of PG&E and GWF, Navigant Consulting conducted this impact study using the following assumptions:

- a) The maximum delivery from the Project to the PG&E transmission grid would be 171.8 MW (initial phase) and 251.7 MW (ultimate).
- b) Other new generation in the study area in 2003 would include:

- The 880 MW Delta Energy Center,
- The La Paloma generation facility with an output of 1,110 MW in summer and 1,160 MW in spring and winter
- The 500 MW Los Medanos Energy Center
- The 338 MW Sunrise Generation Facility
- The 1,080 MW Moss Landing Power Project
- The Midway-Sunset Project with an output of 490 MW in the summer, 540 MW in the spring, and 540 MW in the winter
- The 500 MW Elk Hills Power Project
- The 525 MW Sutter Project
- The 600 MW Metcalf Energy Center
- The 99 MW Hanford Project
- The 590 MW Contra Costa Power Plant Capacity Increase Project
- The 150 MW High Winds Project
- The 1,200 MW Morro Bay Modernization Project
- The 22 MW Stockton Cogen Project
- The 150 MW West Project Units 1-3
- The 560 MW Elverta Project
- A 22 MW peaker project interconnecting to Stockton “A” #1 60-kV line
- A 49 MW peaker project interconnecting with the Tesla-Stockton Cogen Jct. 115-kV line

c) Additional new generation in the 2004 case includes:

- The 530 MW Three Mountain Power Project
- The 595 MW United Golden Gate Power Project
- The 600 MW Potrero Unit 7 Project
- The 1,070 MW East Altamont Generating Project
- A 1,156 MW project, interconnecting to the 230-kV bus at Tesla Substation
- A 581 MW project, interconnecting to the 230-kV bus at Los Esteros Substation
- A 1000 MW project in the Fresno area.
- A 630 MW project, interconnecting with the Cottonwood – Vaca Dixon 230-kV lines.

- A 620 MW project, interconnecting at the East Shore 230-kV bus.
- d) Approved transmission reliability projects (that would be operational by summer 2003 and 2004) would include:
- A third 500/230-kV transformer at Tesla Substation
 - A second 500/230-kV transformer at Tracy Substation
 - A third 500/230-kV transformer at Metcalf Substation
 - A new Tesla-Newark 230-kV line
 - Looping the Newark-San Mateo 230-kV line into the Ravenswood Substation
- e) The transfer limits of the California-Oregon Intertie (Path 66), the South-of-Los Banos Path (Path 15), and the Midway-Vincent 500-kV path (Path 26) would not be increased to accommodate the Project output.
- f) The interconnection between the Project and the PG&E transmission system would be accomplished as discussed above.

5. POWER FLOW STUDY BASE CASE ASSUMPTIONS

Because of the limited amount of time available to Navigant Consulting to complete the requested studies, the parties agreed that, a 2004 summer peak case which Navigant Consulting had obtained from PG&E and utilized in studies for another project could be modified and used for these studies. Navigant Consulting modified this case so that it modeled 2003 summer peak loads in the pertinent areas, the new generators in the queue ahead of the Project, and the approved PG&E transmission reliability projects and projects being developed by others that will be operational by summer 2003 (as listed above).

6. GENERAL CRITERIA FOR IDENTIFYING OVERLOADS

6.1 Normal Overloads

Normal overloads are those that exceed 100% of normal interior summer ratings¹ in the summer base cases and 100% of the normal winter ratings² in the winter basecases.

¹ Summer normal interior ratings are calculated using a wind speed of 2 feet/second, an ambient temperature of 43°C, and a conductor temperature of 75°C for AAC and CU conductors. For other standard type conductors such as ACSR and ACSS the conductor temperatures used in the calculations are 80°C and 200°C respectively. A 4 feet/second wind speed is used on an exception basis.

² Winter normal ratings are calculated using a wind speed of 2 feet/second, an ambient temperature of 16°C, and a conductor temperature of 75°C for AAC and CU conductors. For other standard type conductors such as ACSR and ACSS the conductor temperatures used in the calculations are 80°C and 200°C respectively. A 4 feet/second wind speed is used on an exception basis.

6.2 *Emergency Overloads*

Emergency overloads are those that exceed 100% of emergency interior summer ratings³ in the summer basecases and 100% of the normal winter ratings⁴ in the winter basecases. The emergency overloads refer to overloads that occur during single (ISO Category B⁵) and multiple (ISO Category C⁶) contingencies.

6.3 *ISO Category “B” and “C” Classifications*

ISO Category “B”

- single generator outages
- single (60-500kV) transmission circuit outages
- single transformer outages

ISO Category “C”

- bus section outages
- outage cause by breaker failures
- combination of any two generator/transmission line/transformer outages
- outages of double circuit tower lines

7. **STEADY STATE POWER FLOW STUDY RESULTS**

The 2003 and 2004 Heavy Summer Full Loop Basecases described in Section 5 were used to assess system loading without any contingencies (N-0 conditions) and for the assessment of system impacts for single and multiple (ISO Categories “B” and “C”) outages for both pre- and post-Project conditions. The outages simulated consisted of those on 70-kV, 115-kV, and 230-kV transmission facilities within PG&E’s Stockton and Stanislaus planning areas, as well as on selected 500-kV facilities in northern California.

³ Summer emergency interior ratings are calculated using a wind speed of 2 feet/second, an ambient temperature of 43°C, and a conductor temperature of 85°C for AAC and CU conductors. For ACSR and ACSS conductors, the conductor temperatures used in the calculations are 90°C and 200°C respectively. A 4 feet/second wind speed is used on an exception basis.

⁴ Winter emergency ratings are calculated using a wind speed of 2 feet/second, an ambient temperature of 16°C, and a conductor temperature of 85°C for AAC and CU conductors. For ACSR and ACSS conductors, the conductor temperatures used in the calculations are 90°C and 200°C respectively. A 4 feet/second wind speed is used on an exception basis.

⁵ ISO Category B – refers to all single outages, i.e., a generator, a transmission circuit or a transformer bank.

⁶ ISO Category C – refers outages resulted from the loss of two or more (multiple) components.

Results of the N-0 studies, 115-kV N-1 screening studies, and ISO Category B and C outages are summarized in Table 7-1. Review of the information in Table 7-1 shows that the addition of a two unit TPP:

- Does not result in any new overloads on the PG&E system or increase any pre-TPP overloads under N-0 conditions (those in which no lines or transformers have been forced out of service).
- In 2003, results in two small overloads (1% and 2%) that result from screening level outages on the 115-kV system in the Project area.
- In 2004, results in two overloads that result from screening level outages on the 115-kV system in the Project area increasing by 2% and 6%,. The larger of these two increases is noted on the Kasson-Kasson Jct 2 115-kV line and could likely be mitigated by replacing or upgrading line switches.
- In 2004, does not result in any new overloads due to Category B outages and mitigates two such overloads noted for the pre-Project case. The addition of the Project does result in slight increases (2-5%) in some overloads. Methods of mitigating these incremental overloads would be dependent on the method(s) selected by PG&E to mitigate the pre-Project overloads.
- In 2004, reduces the potential for and the magnitude of overloads on the Tracy JC-Ellis line that result from N-2 outages on various segments of the Tesla-Kasson and Tesla-Manteca lines.

The information in Table 7-1 shows that, if a three unit Project were developed, doing so:

- Does not result in any new overloads on the PG&E system or increase any pre-TPP overloads under N-0 conditions (those in which no lines or transformers have been forced out of service).
- In 2003, results in an overload of 5% on the Kasson-Kasson Jct 2 115-kV line as a result of screening outages on the 115-kV system.
- In 2004, results in the overload on the Kasson-Kasson Jct 2 115-kV line that results from screening level outages on the 115-kV system in the Project area increasing by 9%.
- In 2004, does not result in any new overloads due to Category B outages and mitigates two such overloads noted for the pre-Project case. The addition of the Project does result in slight increases (4-5%) in some overloads. Methods of mitigating these incremental overloads would be dependent on the method(s) selected by PG&E to mitigate the pre-Project overloads.

- In 2004, reduces the potential for and the magnitude of overloads on the Tracy JC-Ellis line that result from N-2 outages on various segments of the Tesla-Kasson and Tesla-Manteca lines.

8. TRANSIENT STABILITY STUDY RESULTS

Stability studies were performed to ensure that the transmission system would remain in operating equilibrium through normal and abnormal operating conditions after the Project is operational.

8.1 Summary of the Stability Studies

Appendix E of this report includes stability plots for the scenarios outlined in Section 8.2. The plots show the corresponding bus profiles over a 20 second study period. Plots for all thirty-three outage scenarios with Phase 2 of the GWF Tracy Project included in the model are included in Appendix E. In addition, plots for the thirteen 115-kV outages simulated with only Phase 1 of the GWF Tracy Project included in the model are included in Appendix E.

All but one of the simulations plots demonstrated satisfactory results. The exception occurred when a 15 cycle fault was applied on the Tesla 115-kV bus and was cleared by opening the Tesla 230/115 kV Bank #3 (Outage J). Doing so resulted in continuous voltage and frequency oscillations on the local 115 kV and 230 kV buses. However, these oscillations also occur for the same outage simulated on the pre-project model and, therefore, do not appear to be due to the addition of the GWF Tracy Project

The machine dynamics data used to perform the studies was supplied by GWF. Block diagrams for exciter, generator, and governor models for these machines are contained in Appendix D.

8.2 Simulated Disturbances

The following simulations were performed for a study period of 20 seconds to determine whether the Project would result in system instability during selected the Category “B” and Category “C” contingencies.

TABLE 7-1 RESULTS OF POWERFLOW STUDIES								
No. of Increased Overloads	Critical Outage	Impacted Element(s)	2003 Conditions			2004 Conditions		
			Pre- Project	2 Unit Project	3 Unit Project	Pre- Project	2 Unit Project	3 Unit Project
N-0 Conditions								
0	None	Manteca 115/60-kV Transfromer	104	100	99	102	100	98
115-kV Screening Outages								
1	Safeway Tap 1-Owens Tap 1 (pre)/ GWF Tap 1 – Owens Tap 1 (post)	Tracy JC-Ellis 115-kV line	99	101	<95	104	106	<95
0	Safeway Tap 2-Owens Tap 2 (pre)/ GWF Tap 2 – Owens Tap 2 (post)	Tracy JC-Ellis 115-kV line	96	<95	<95	102	<95	<95
0	AEC Tap 1 – Safeway Tap 1	Tracy JC – Ellis 115-kV line	101	<95	<95	106	<95	<95
1	Tesla – Ellis	Kasson – Kasson Jct 2 115-kV line	97	102	105	101	107	110
Category B Outages								
0	OI Glass-Owens Tap-Kasson 115-Kv line	Tracy JC – Ellis 115-kV line				101	<95	<95
1	Tesla 500/230-kV #2 transformer	Tesla D-Tesla E 230-kV tie				106	108	110
2	Manteca 116/60-kV #3 transformer	Kasson-Calvo 60-kV line				113	116	116
		MSSDLESW-Calvo 60-kV line				107	111	111
1	Stanislaus Gen & Tesla JC –Ellis line	Kasson-Kasson Jct 2 115-kV tie				107	112	116
	Stanislaus Gen. & Manteca-Kasson Jct 1 line	Tracy JC – Ellis 115-kV line				112	<95	<95
Category C Outages								
	Tesla-Kasson and Tesla-Manteca 115-kV lines	Tracy JC-Ellis 115-kV line				194	----	----
	GWF-Kasson and Tesla-Manteca 115-kV lines	Tracy JC – Ellis 115-kV line				----	153	---
	GWF-Kasson and GWF-Manteca 115-kV lines	Tracy JC – Ellis 115-kV line				----	----	160

NERC/CAISO Category “B” Contingencies:

- a) Full load rejection of the proposed 258 MW power plant.
- b) A three-phase fault with the normal clearing time at the GWF Tracy Substation 115 kV bus, followed by loss of one of the GWF Tracy Peaker - Tesla 115 kV lines.
- c) A three-phase fault with the normal clearing time at the GWF Tracy Substation 115 kV bus, followed by loss of the GWF Tracy - Kasson 115 kV line.
- d) A three-phase fault with the normal clearing time at the GWF Tracy Substation 115 kV bus, followed by loss of the GWF Tracy - Manteca 115 kV line.
- e) A three-phase fault with the normal clearing time at the Tesla 115 kV bus, followed by loss of the Tesla - Tracy 115 kV line.
- f) A three-phase fault with the normal clearing time at the Tesla 115 kV bus, followed by loss of the Tesla - Salado - Manteca 115 kV line.
- g) A three-phase fault with the normal clearing time at the Kasson 115 kV bus, followed by loss of the Vierra - Tracy - Kasson 115 kV line (formerly known as the Manteca - Kasson 115 kV line).
- h) A three-phase fault with the normal clearing time at the Tesla 115 kV bus, followed by loss of the Tesla - Stockton Co-Gen 115 kV line.
- i) A three-phase fault with the normal clearing time at the Tesla 115 kV bus, followed by loss of Tesla Bank #1 (230/115 kV bank).
- j) A three-phase fault with the normal clearing time at the Tesla 115 kV bus, followed by loss of Tesla Bank #3 (230/115 kV bank).
- k) A three-phase fault with the normal clearing time at the Tesla 230 kV bus, followed by loss of the Tesla - Tracy #1 230 kV line.
- l) A three-phase fault with the normal clearing time at the Tesla 230 kV bus, followed by loss of the Tesla - Newark 230 kV line.
- m) A three-phase fault with the normal clearing time at the Tesla 230 kV bus, followed by loss of the Tesla - Ravenswood 230 kV line.
- n) A three-phase fault with the normal clearing time at the Tesla 230 kV bus, followed by loss of the Pittsburg - Tesla #1 230 kV line.
- o) A three-phase fault with the normal clearing time at the Tesla 230 kV bus, followed by loss of the Pittsburg - Tesla #2 230 kV line.
- p) A three-phase fault with the normal clearing time at the Tesla 500 kV bus, followed by loss of the Tesla 500/230 kV Bank #2.

NERC/CAISO Category “C” Contingencies:

- a) A three-phase fault with the 6-cycle normal clearing time on Tesla 115 kV buses
 - 1) Bus 1
 - 2) Bus 2
- b) A three-phase fault with the normal 6-cycle clearing time on Tesla 230 kV buses
 - 1) Bus 1, Sect. D
 - 2) Bus 2, Sect. D
 - 3) Bus 1, Sect. E
 - 4) Bus 2, Sect. E
 - 5) Bus 1, Sect. F
 - 6) Bus 2, Sect. F
- c) A three-phase fault with the normal clearing time on the Tesla 115 kV bus, followed by simultaneous loss of Tesla - Stockton Co-Gen 115 kV Line and Tesla Bank #3 (230/115 kV bank).
- d) A three-phase fault with the normal 6-cycle clearing time at the Tesla 230 kV bus, followed by simultaneous loss of Tesla - Newark #1 and Tesla - Ravenswood #1 230 kV lines.
- e) A three-phase fault with the normal 6-cycle clearing time at the Tesla 230 kV bus, followed by simultaneous loss of Tesla - Pittsburg #1 and #2 230 kV lines.
- f) A three-phase fault with the normal 6-cycle clearing time at the Tesla 230 kV bus, followed by simultaneous loss of Tesla - Tracy #1 and #2 230 kV lines.
- g) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by a simultaneous loss of the Table Mountain-Tesla and Vaca-Tesla 500 kV lines.
- h) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by a simultaneous loss of the Tesla-Tracy and Tesla-Los Banos 500 kV lines.
- i) A single-line-to-ground fault at one of the line breakers at the Tesla 230 kV bus Section D, with a breaker failure condition.
- j) A single-line-to-ground fault at one of the line breakers at the Tesla 230 kV bus Section E, with a breaker failure condition.

9. SHORT CIRCUIT STUDY RESULTS

Due to time constraints it was not possible to perform short circuit studies for faults at the Tesla busses for either of the Project sizing scenarios discussed above. PG&E did perform studies that indicate that the fault currents at the GWF interconnection point would

range from approximately 15,000 amps (for a two-unit Project) to approximately 21,000 amps (for a three-unit Project). In addition, PG&E had previously performed short circuit studies for a configuration in which the Project was interconnected with the Tesla 230-kV bus. The results of these studies are summarized in Table 9-1; review of the information in Table 9-1 shows that:

- a) Fourteen 230-kV breakers connected to the “D” bus at Tesla are overstressed in the pre-Project studies in amounts ranging from 3% to 51%. The addition of the TPP increased the overload on these breakers by about 1.1%.
- b) Four 230-kV breakers connected to the “E” bus at Tesla are overstressed in the pre-Project studies by 27%. The addition of the TPP increased these overloads by about 3.5%.
- c) One 115-kV breaker at Tesla is overstressed in the pre-Project studies (by 25%). The addition of the TPP had little impact on this overload.

Because the fault duties at Tesla should decrease if the Project is interconnected with the 115-kV system, it is likely that the results of short circuit studies for a 115-kV interconnection would be lower than would those for a 230-kV interconnection.

TABLE 9-1						
SUMMARY OF SHORT CIRCUIT STUDY RESULTS						
Bus	Breaker Number(s)	Interrupting Capacity (Amps)	Maximum Fault Current ¹			
			2003 Pre-Project		2003 Post-Project	
			Amps	% of Rating	Amps	% of Rating
Tesla D 230-kV	312	43,000	64,885	151	65,572	152
	322, 332, 342, 362, 372, 392, 812, 822	50,000	64,885	130	65,572	131
	202, 352, 382, 842, 892,	63,000	64,885	103	65,572	104
Tesla E 230-kV	252, 262, 272, 282	43,000	54,483	127	56,397	131
	212, 222, 232, 242, 292, 882	63,000	54,483	86	56,397	90
Tesla 115-kV	432	25,000	31,308	125	31,345	125
^{1/} Three-phase for Tesla 230-kV and line-to-ground for Tesla 115-kV						

It is GWF’s understanding that current PG&E guidelines state that the Applicant is responsible for replacement of a breaker if:

1. The Project causes the breaker to be overstressed by 10% or more, or
2. If the breaker is already overstressed and the Project increases the overstress by 10% or more.

Based on these guidelines, the TPP, when interconnected at the Tesla bus, should not be responsible for replacing any breakers at Tesla because:

- a) The addition of the TPP does not result in any new overstressed breakers, and
The addition of the TPP does not increase the overstress on any breakers by more than 5%.

APPENDIX A

CONTINGENCY LISTS

APPENDIX B

**RESULTS OF
POWERFLOW
STUDIES**

APPENDIX C

**POWERFLOW
DIAGRAMS**

APPENDIX D

**DYNAMICS DATA
FOR GWF MACHINES**

APPENDIX E

STABILITY PLOTS